



## Spectrum & Lightcurve Reveal Explosion Initial Conditions

Observables	$^{56}\text{Ni}$ Mass	$^{56}\text{Ni}$ Distribution	Kinetic Energy	Opacity	Metal- licity
Spectral feature minima	○	—	●	○	●
Spectral feature widths	○	—	●	○	●
Spectral feature Ratios	●	—	○	○	●
Lightcurve Stretch	●	○	○	●	—
Lightcurve Rise Time	●	●	○	○	○
Lightcurve Peak/Tail	○	—	○	●	—

- = directly related to model parameter
- = indirectly related to model parameter
- = slightly related to or no relation to the model parameter

*SNAP will measure all of these Observables*  
**pre-cursor SNfactory will provide calibration**

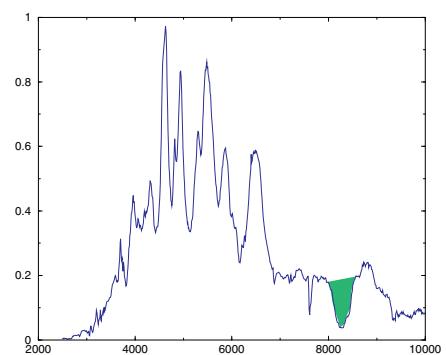
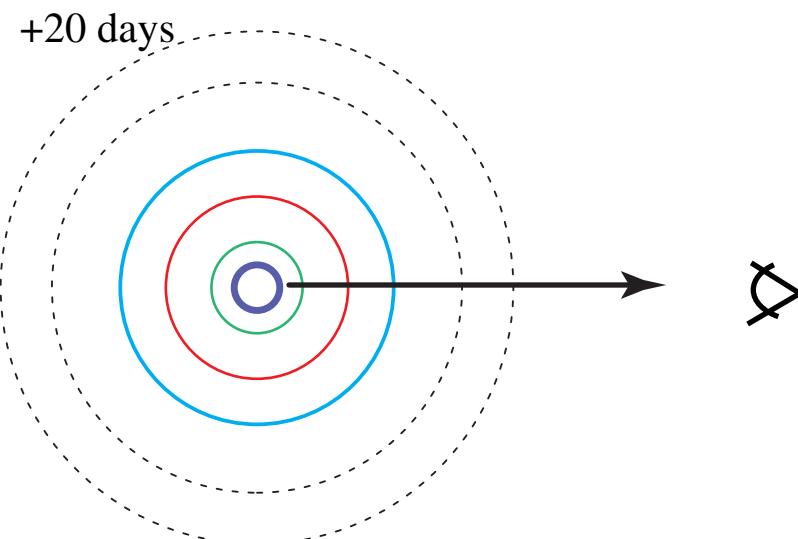
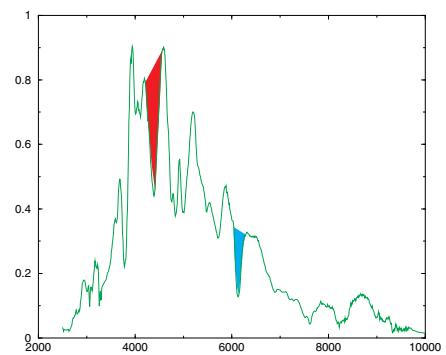
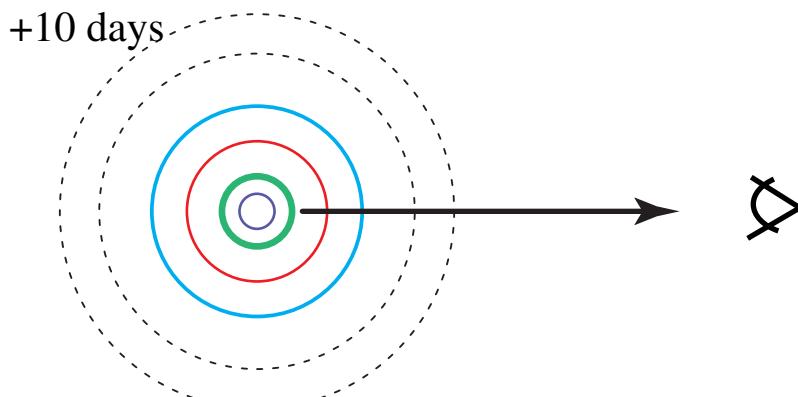
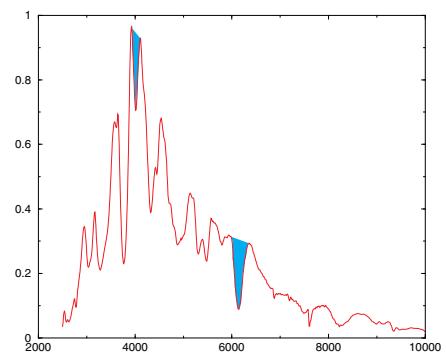
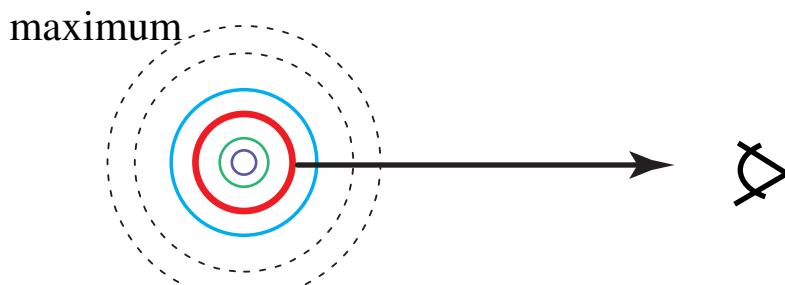
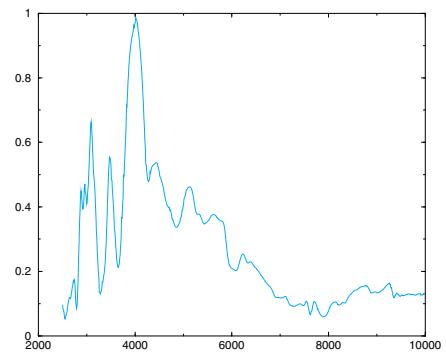
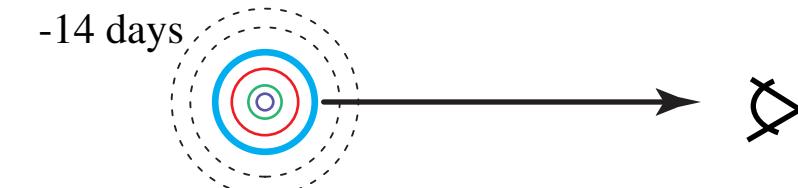


## Accuracy to Measure Explosion Initial Conditions

Spectrum Observables $X$	$\partial M_{peak}/\partial X$ (rest frame)	Requirement for $m_{sys} < 0.02$
Feature minima	0.04/500 km/s	250 km/s
Feature widths	0.03/1200 km/s	500 km/s
Feature Ratios	0.12 (@ $B$ ), -0.75 (@ $\lambda = 3000\text{\AA}$ ), 1.5 (@ $\lambda = 6150\text{\AA}$ )	5%

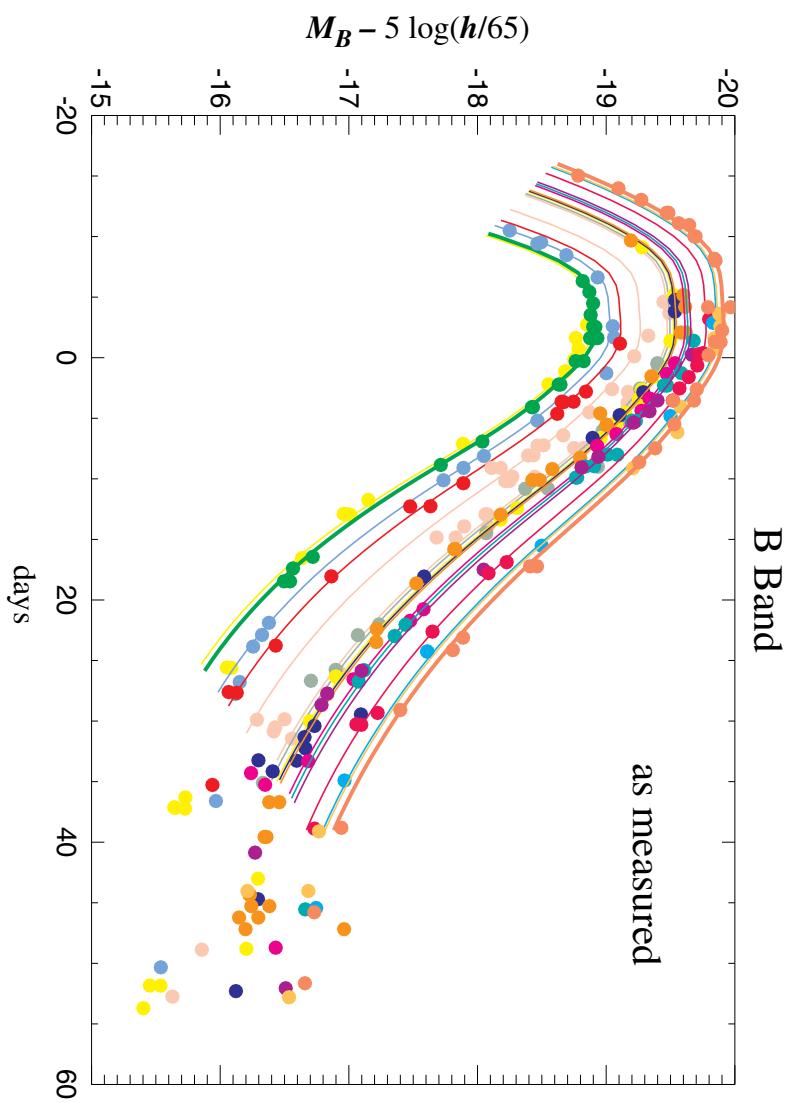
Light Curve Observables $X$	$\partial M_{peak}/\partial X$ (rest frame)	Requirement for $m_{sys} < 0.02$
Stretch	0.10/5%	1%
Rise Time	0.07/1 day	0.3 days
Peak to tail ratio	0.05/0.2 mag	0.05 mag

The time series of spectra is a “CAT Scan” of the Supernova



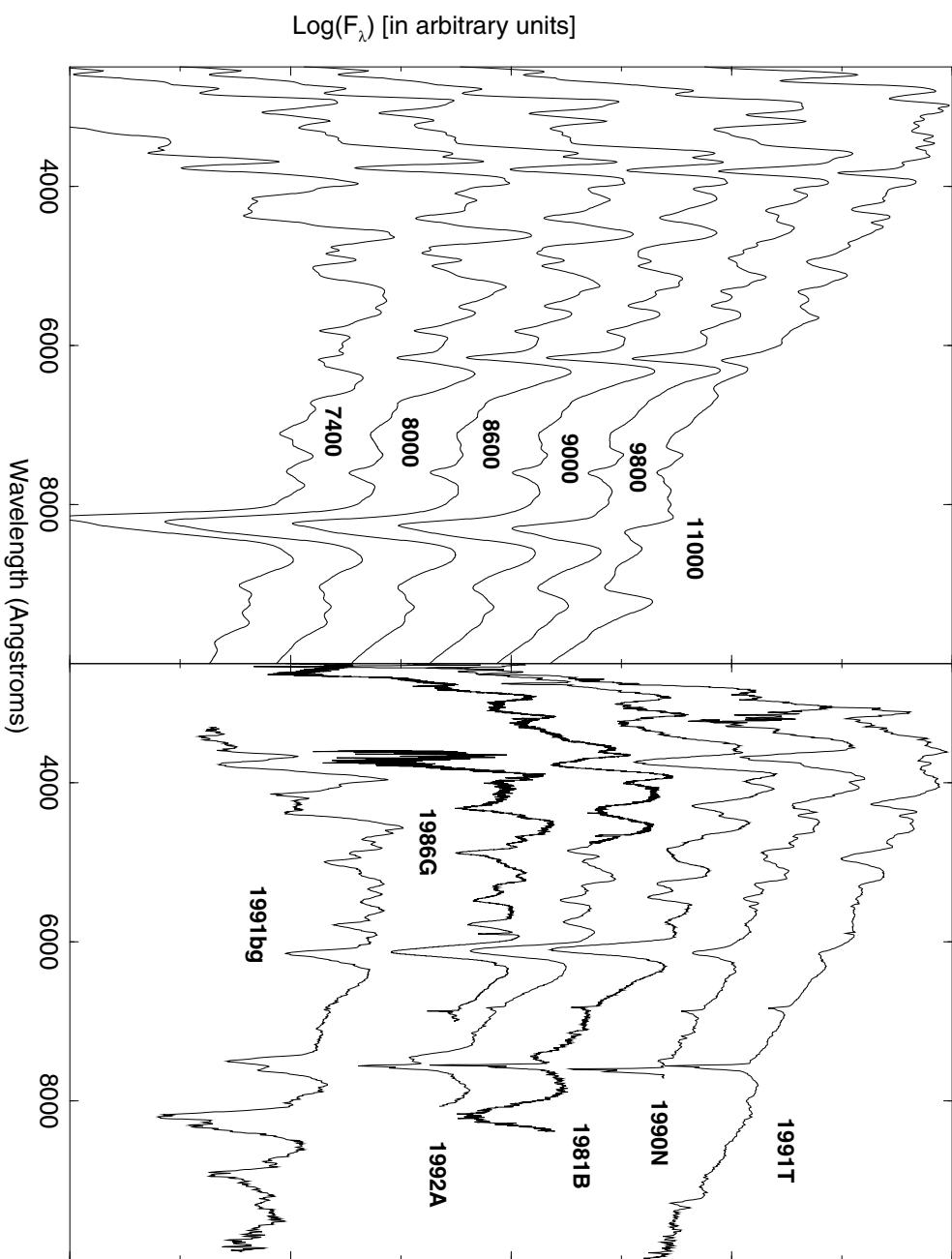
# Explaining the Behavior of Supernovae

Type Ia Supernovae Light-Curve Shape and Spectral Correlations



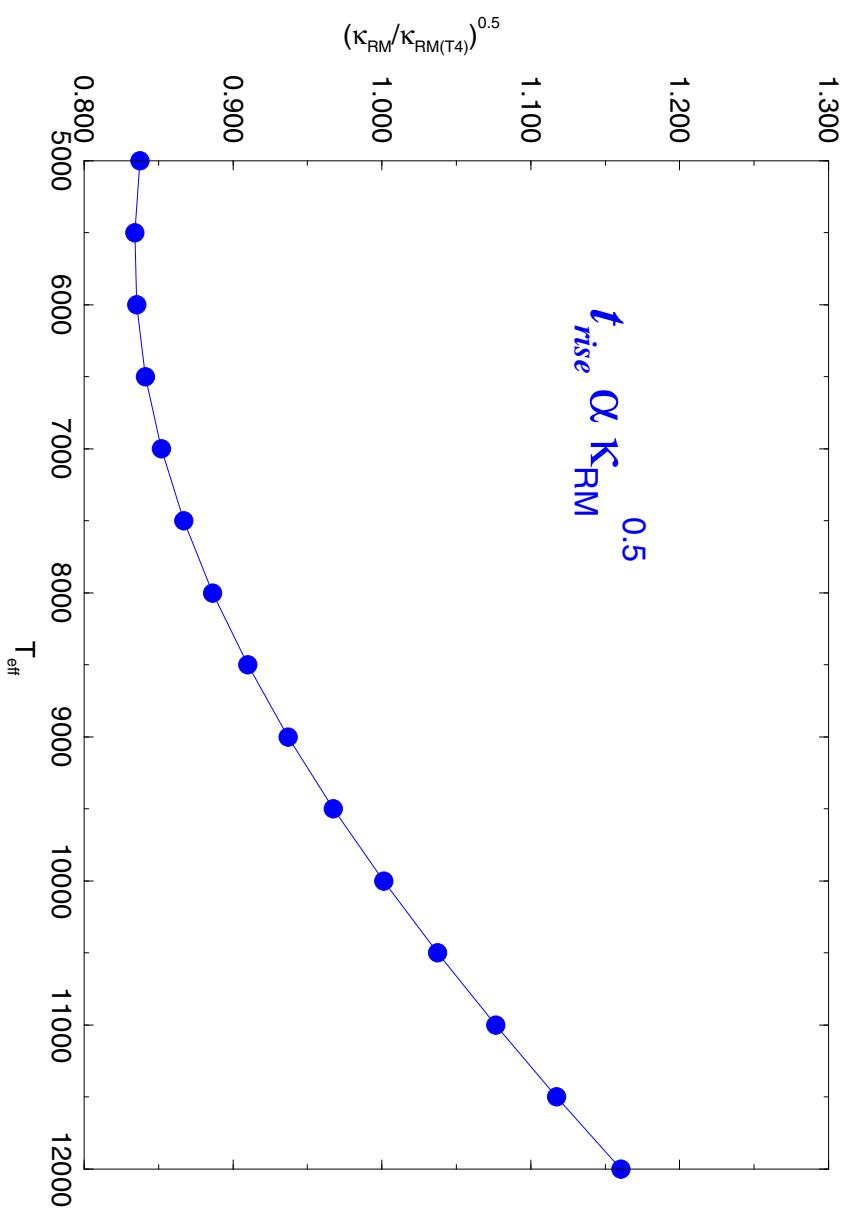
# Explaining the Behavior of Supernovae

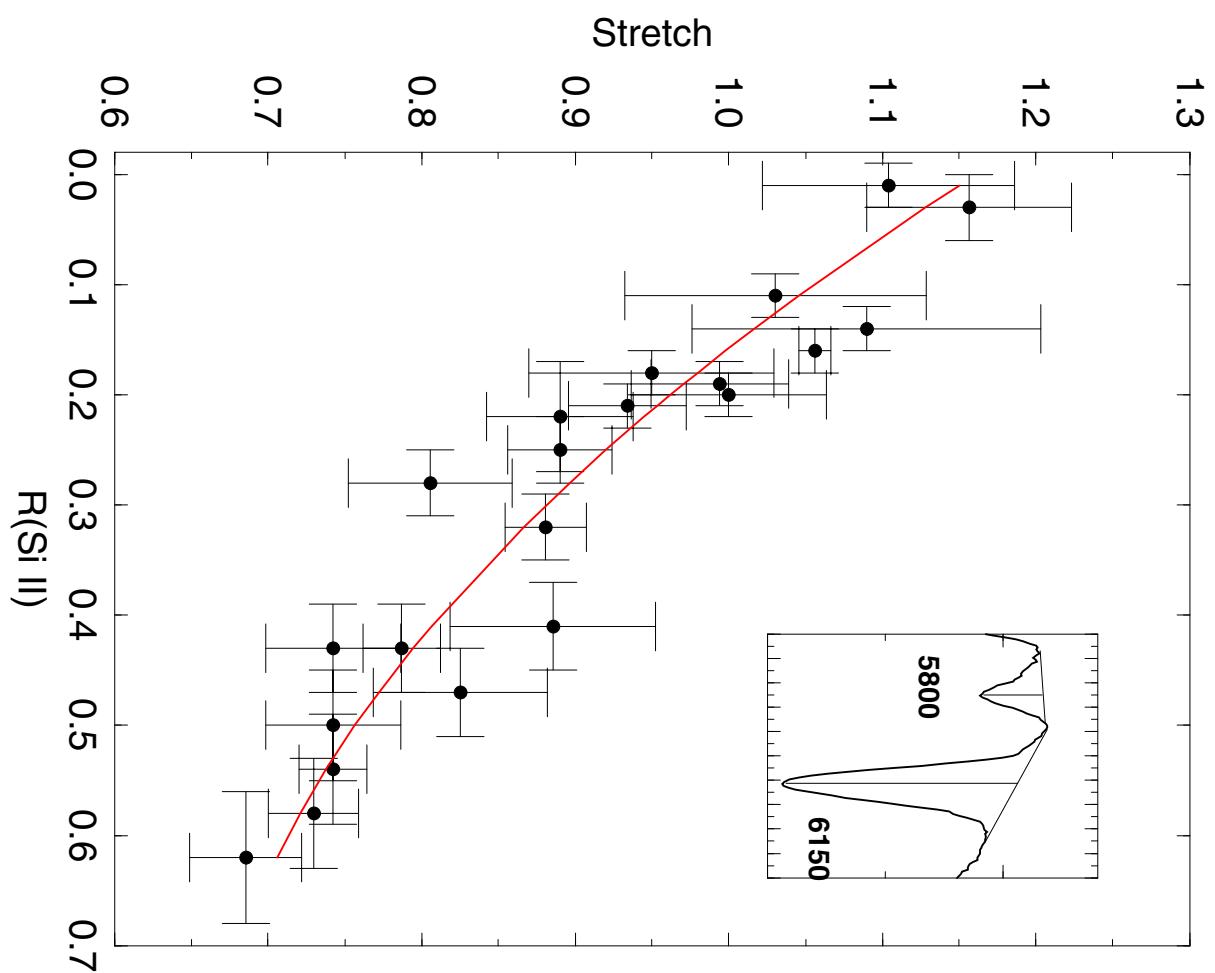
Type Ia Supernovae Light-Curve Shape and Spectral Correlations



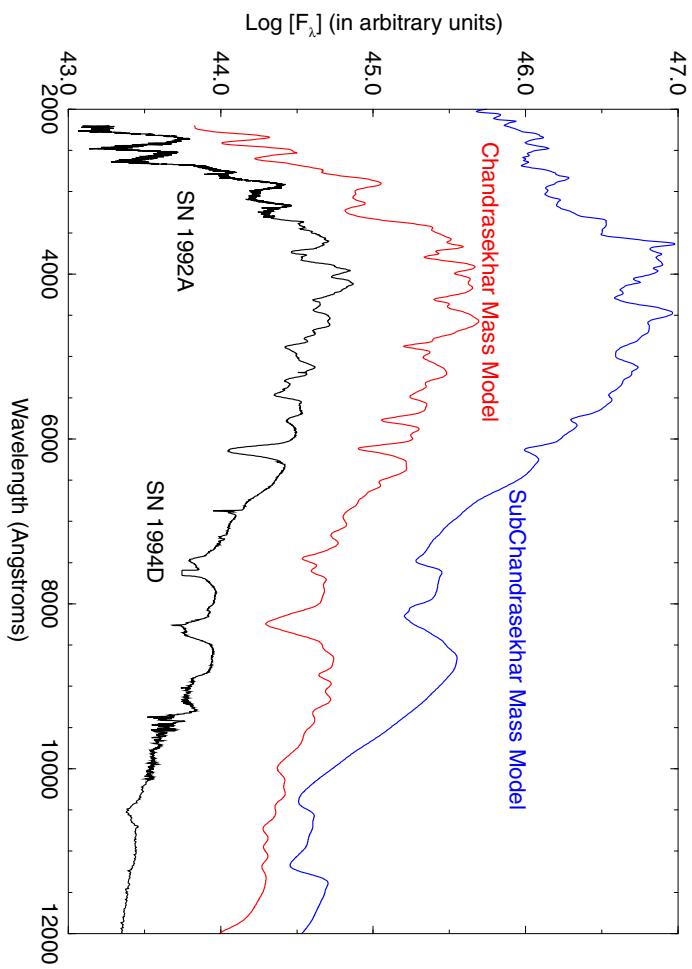
# Explaining the Behavior of Supernovae

Type Ia Supernovae Light-Curve Shape and Spectral Correlations



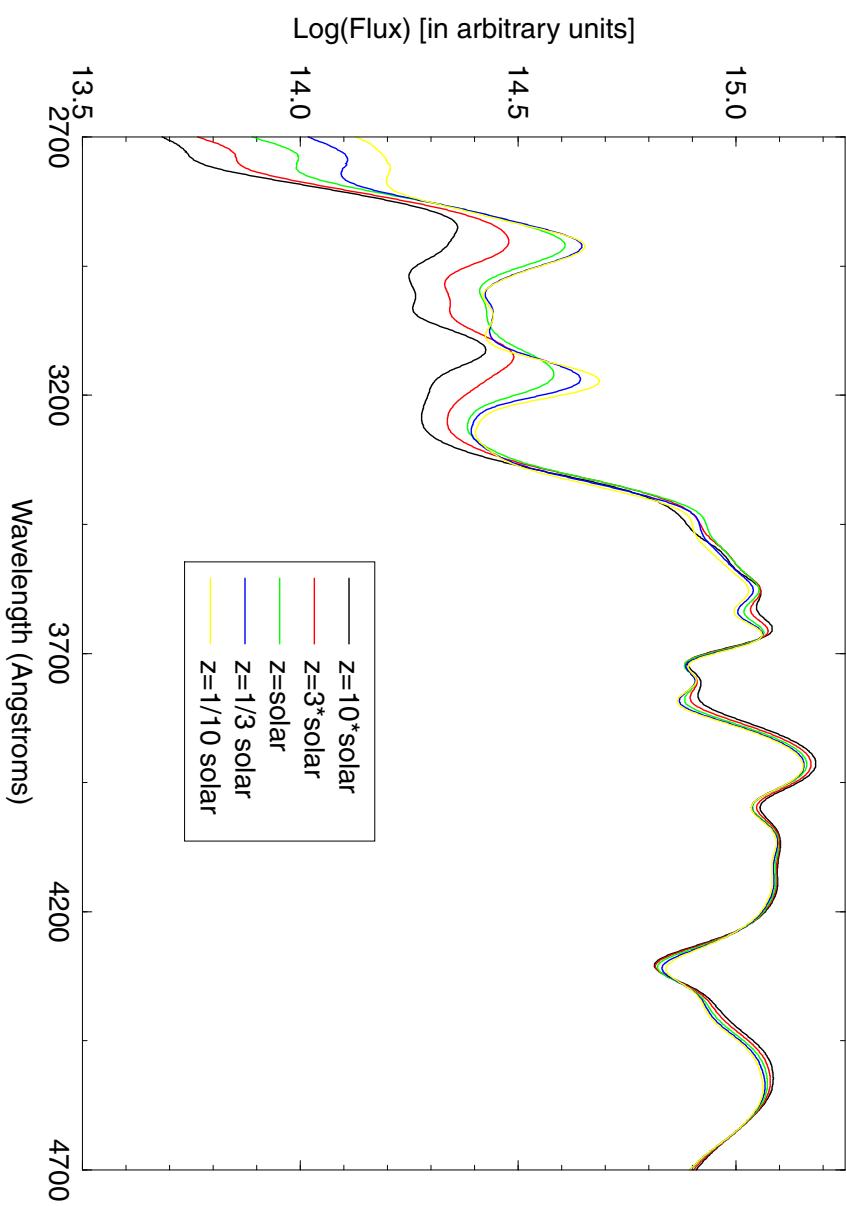


# Validation of Hydrodynamical Models



# Search for Evolutionary Effects

Metallicity Differences in Type Ia Supernova Spectra



# Spectroscopy Science Requirements for SNAP

## SN 1984A

L82

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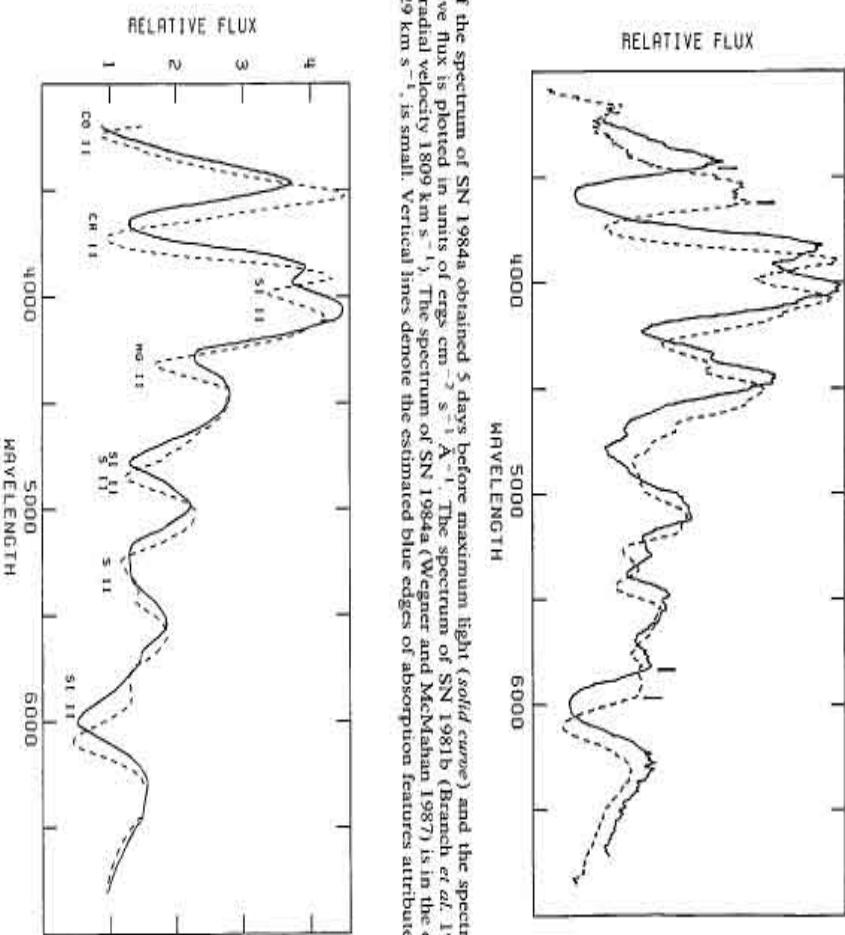


FIG. 1.—Comparison of the spectrum of SN 1984A obtained 5 days before maximum light (solid curve) and the spectrum of SN 1981b at maximum light (dashed curve). Relative flux is plotted in units of  $\text{ergs cm}^{-2} \text{s}^{-1} \text{\AA}^{-1}$ . The spectrum of SN 1981b (Branch *et al.* 1983) is in the rest frame of its parent galaxy (NGC 4536; radial velocity  $809 \text{ km s}^{-1}$ ). The spectrum of SN 1984A (Wegener and McMathan 1987) is in the observer's frame, but the radial velocity of NGC 4419,  $-229 \text{ km s}^{-1}$ , is small. Vertical lines denote the estimated blue edges of absorption features attributed to unresolved Ca II and Si II doublets.

FIG. 2.—Comparison of synthetic spectra calculated for velocities at the photosphere of  $16,300 \text{ km s}^{-1}$  (solid curve) and  $12,000 \text{ km s}^{-1}$  (dashed curve)

